

WHAT IS CLAIMED IS:

1. A hydraulic brake apparatus for a vehicle comprising:

a pressure source for generating hydraulic pressure;

a pressure regulator valve for regulating the hydraulic pressure generated by said pressure source in response to an input state;

a master cylinder having a master piston for defining a pressure chamber for receiving therein the hydraulic pressure fed from said pressure regulator valve, and a master chamber for discharging hydraulic braking pressure, said master piston being advanced by the hydraulic pressure in said pressure chamber to discharge the hydraulic braking pressure from said master chamber, wherein the hydraulic braking pressure discharged from said master chamber is set to be lower than the hydraulic pressure in said pressure chamber, to produce a pressure difference increased in response to advance of said master piston;

a wheel brake cylinder operatively mounted on each wheel of said vehicle for applying braking force to said wheel with the hydraulic braking pressure fed from said master chamber;

pressure control means disposed between said master chamber and said wheel brake cylinder for controlling the hydraulic braking pressure in said wheel brake cylinder; and

pressure supply means for supplying the hydraulic

pressure in said pressure chamber reduced in pressure by a predetermined value, into said master chamber.

2. A hydraulic brake apparatus as set forth in claim 1, wherein said master cylinder includes a return spring for biasing said master piston, with a load applied thereto for providing the hydraulic braking pressure discharged from said master chamber to be lower than the hydraulic pressure in said pressure chamber, to produce the pressure difference increased in response to advance of said master piston.

3. A hydraulic brake apparatus as set forth in claim 1, wherein said pressure supply means includes a relief valve for communicating said pressure chamber with said master chamber when the hydraulic braking pressure in said master chamber is lower than the hydraulic pressure in said pressure chamber by a value equal to or greater than the predetermined value.

4. A hydraulic brake apparatus as set forth in claim 3, wherein said pressure supply means further includes a normally closed switching valve with one port thereof connected to said pressure chamber and the other one port connected to said relief valve.

5. A hydraulic brake apparatus as set forth in claim 1, wherein said pressure supply means reduces the hydraulic pressure in said pressure chamber to be supplied into said master chamber, up to the value reduced in pressure for allowing said master piston to return to a predetermined position in said master cylinder.

6. A hydraulic brake apparatus as set forth in claim 5, wherein said predetermined position is set to be a position immediately before a rearmost initial position of said master piston returns.

7. A hydraulic brake apparatus as set forth in claim 1, wherein said pressure control means communicates said wheel brake cylinder with a reservoir for storing brake fluid under atmospheric pressure, when the hydraulic braking pressure in said wheel brake cylinder is to be reduced.

8. A hydraulic brake apparatus as set forth in claim 1, wherein said master cylinder includes:

a first master piston formed by said master piston;

a second master piston disposed in said master cylinder in front of said first master piston, with a predetermined distance spaced between said first master piston and said second master piston to define a first master chamber therebetween, and define a second master chamber between said second master piston and a front end of said master cylinder;

a first return spring disposed in said first master chamber; and

a second return spring disposed in said second master chamber,

wherein a load for mounting said first return spring being set to be greater than a load for mounting said second return spring, and

wherein said pressure supply means supplies the

hydraulic pressure in said pressure chamber reduced in pressure by a predetermined value, into said first master chamber and second master chamber.

9. A hydraulic brake apparatus as set forth in claim 8, wherein said pressure control means communicates said wheel brake cylinder with a reservoir for storing brake fluid under atmospheric pressure, when the hydraulic braking pressure in said wheel brake cylinder is to be reduced.

10. A hydraulic brake apparatus as set forth in claim 8, wherein said pressure supply means comprises a first relief valve connected to said first master chamber, a second relief valve connected to said second master chamber, and a normally closed switching valve with one port thereof connected to said pressure chamber and the other one port connected to said first relief valve and second relief valve.

11. A hydraulic brake apparatus as set forth in claim 8, wherein said pressure supply means comprises a first normally closed switching valve connected to said first master chamber, a second normally closed switching valve connected to said second master chamber, and a relief valve with one port thereof connected to said pressure chamber and the other one port thereof connected to said first normally closed switching valve and second normally closed switching valve.

12. A hydraulic brake apparatus for a vehicle comprising:

a pressure source for generating hydraulic

pressure;

a reservoir for storing brake fluid under atmospheric pressure;

changeover means for controlling the communication between said reservoir and said pressure source;

a master cylinder having a master piston for defining a pressure chamber for receiving therein the hydraulic pressure fed from said pressure source and drained to said reservoir through said changeover means to be controlled thereby into a predetermined pressure, and a master chamber for discharging hydraulic braking pressure, said master piston being advanced by the hydraulic pressure in said pressure chamber to discharge the hydraulic braking pressure from said master chamber, wherein the hydraulic braking pressure discharged from said master chamber is set to be lower than the hydraulic pressure in said pressure chamber, to produce a pressure difference increased in response to advance of said master piston;

a wheel brake cylinder operatively mounted on each wheel of said vehicle for applying braking force to said wheel with the hydraulic braking pressure fed from said master chamber;

pressure control means disposed between said master chamber and said wheel brake cylinder for controlling the hydraulic braking pressure in said wheel brake cylinder; and

pressure supply means for supplying the hydraulic pressure in said pressure chamber reduced in pressure by a

predetermined value, into said master chamber.

13. A hydraulic brake apparatus as set forth in claim 12, wherein said master cylinder includes a return spring for biasing said master piston, with a load applied thereto for providing the hydraulic braking pressure discharged from said master chamber to be lower than the hydraulic pressure in said pressure chamber, to produce the pressure difference increased in response to advance of said master piston.

14. A hydraulic brake apparatus as set forth in claim 12, wherein said pressure supply means includes a relief valve for communicating said pressure chamber with said master chamber when the hydraulic braking pressure in said master chamber is lower than the hydraulic pressure in said pressure chamber by a value equal to or greater than the predetermined value.

15. A hydraulic brake apparatus as set forth in claim 14, wherein said pressure supply means further includes a normally closed switching valve with one port thereof connected to said pressure chamber and the other one port connected to said relief valve.

16. A hydraulic brake apparatus as set forth in claim 12, wherein said pressure supply means reduces the hydraulic pressure in said pressure chamber to be supplied into said master chamber, up to the value reduced in pressure for allowing said master piston to return to a predetermined position in said master cylinder.

17. A hydraulic brake apparatus as set forth in claim

16, wherein said predetermined position is set to be a position immediately before a rearmost initial position of said master piston returns.

18. A hydraulic brake apparatus as set forth in claim 12, wherein said pressure control means communicates said wheel brake cylinder with said reservoir, when the hydraulic braking pressure in said wheel brake cylinder is to be reduced.

19. A hydraulic brake apparatus as set forth in claim 12, wherein said master cylinder includes:

a first master piston formed by said master piston;

a second master piston disposed in said master cylinder in front of said first master piston, with a predetermined distance spaced between said first master piston and said second master piston to define a first master chamber therebetween, and define a second master chamber between said second master piston and a front end of said master cylinder;

a first return spring disposed in said first master chamber; and

a second return spring disposed in said second master chamber,

wherein a load for mounting said first return spring being set to be greater than a load for mounting said second return spring, and

wherein said pressure supply means supplies the hydraulic pressure in said pressure chamber reduced in

pressure by a predetermined value, into said first master chamber and second master chamber.

20. A hydraulic brake apparatus as set forth in claim 19, wherein said pressure control means communicates said wheel brake cylinder with said reservoir, when the hydraulic braking pressure in said wheel brake cylinder is to be reduced.

21. A hydraulic brake apparatus as set forth in claim 12, wherein said changeover means comprises a first linear proportioning solenoid valve connected to said reservoir and a second linear proportioning solenoid valve connected to said pressure source.